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CARL L. ALSBERG, Chief of Bureau.

# LEATHER INVESTIGATIONS:

## THE COMPOSITION OF SOME SOLE LEATHERS.

BY

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# LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
*Washington, D. C., November 20, 1912.*

SIR: I transmit for your inspection and approval manuscript entitled "Leather Investigations: The Composition of Some Sole Leathers," by F. P. Veitch and J. S. Rogers. The results which have been obtained show that weighting of leathers with useless or harmful materials is extensively practiced. The country's resources in leather materials are thus wasted and the public defrauded. I recommend that this be published as Bureau of Chemistry Bulletin No. 165.

Respectfully,

R. E. DOOLITTLE,
*Acting Chief of Bureau.*

Hon. JAMES WILSON,
*Secretary of Agriculture.*

# CONTENTS.

# LEATHER INVESTIGATIONS: THE COMPOSITION OF SOME SOLE LEATHERS.

## COMPOSITION OF NORMAL SOLE LEATHER.

Vegetable-tanned leather is essentially a compound or mixture of hide or fibrous proteid material with tannin. Depending on the use to which it is to be put, it may be finished in several ways whereby the composition of the final product may differ greatly from the simple compound. The tanned leather may be used without material change in composition, as for shoe soles; it may be greased, as for harness and belting; or it may be greased and dyed, as for harness and shoe uppers.

In addition to the insoluble hide and tannin which are the essential constituents of leather, moisture, mineral matter, fats, and water-soluble tanning materials, which remain to a small extent in well-scoured leather, are present. All of these, when not present in excessive quantities, are proper and normal constituents of the leather. In fact, the presence of a large percentage of oils or fats, even in sole leather, is of decided advantage in increasing the water resistance, flexibility, softness, and life of the leather, while the presence of a small amount of uncombined tannin is often of some advantage in retarding water penetration and hardening of the leather and in making it solid and firm. The presence of a large excess of uncombined tannin materials other than those mentioned is useless or harmful.

Leather is not a definite compound and is therefore impossible to produce of an exact composition. The ratio of combined tannins to hide substances approximates 7 to 10 (see last column of table on pp. 16 to 20), while the percentages of water-soluble constituents, mineral matter, fat, and moisture may vary considerably. Careful study of the analyses of well-tanned, scoured leathers of various tannages, both American and foreign, warrants the conclusion that well-tanned, merchantable, scoured sole leather of all tannages on analysis should give results on a moisture-free basis which fall between the following limits: Leather substance from 75 to 93 per cent, hide substance from 43 to 57 per cent, combined tannins from 31 to 42 per cent, water-soluble materials from 5 to 15 per cent, oils and fats from 1 to 6 per cent, ash from 0.25 to 1 per cent.

Well-tanned, honestly-made leather should approach the upper rather than the lower limits for leather substance and oils and fats. The water-soluble constituents should consist only of the materials contained in the adhering tanning solution which have not been removed in scouring.

Properly air-dried sole leather should not contain, even in very damp weather, more than 20 per cent of moisture, and the average percentages for the year should fall below 15 per cent. Neither the ultimate buyer nor the shoe manufacturer should be called upon to pay for a greater average amount than this. It will be observed that the leathers reported herewith contain much less moisture, due largely to the fact that they dried out very much after reaching the laboratory.

Normal vegetable-tanned sole and harness leather when burned should not leave more than 1 per cent of ash and as a rule not more than 0.5 per cent. This ash is derived from the hide, from the lime used in unhairing, and from the salts usually dissolved in all waters. The magnesia of the ash when calculated to Epsom salts ($MgSO_4+7H_2O$), the form present in air-dried leather, should not exceed 1 per cent.

It is customary abroad to consider less than 2 per cent of glucose permissible, the assumption being that this amount may be present from the tanning materials. It is very doubtful if this amount of glucose is ever present in normal leathers from which the excess of tanning materials has been properly washed. Leathers on which the final liquors were sweet and exceptionally concentrated, and which are subsequently washed but little, may contain between 1 and 2 per cent of sugars, determined as dextrose.

The ether extract or fat may be as high as 5 per cent, probably never much less, to give pliability, water resistance, and durability to the leather.

## WEIGHTING OF LEATHER.

During an extended examination of sole leathers now in progress, it has been found that a surprisingly large percentage contains great quantities of foreign materials. Although it has long been known that some tanners make a practice of weighting or loading their leather, the extent of the practice is not appreciated outside the tanning and closely related industries. Tanners state that leather is loaded with foreign materials because the boot and shoe makers will buy only the lower-priced leather, which, to use a trade expression, "cuts to advantage," that is, from which the greatest number of soles can be cut at the lowest cost a pair. Many boot and shoe manufacturers claim that they use loaded leather because it cuts to better advantage than the same leather not loaded.

The character, value, and wearing quality of leather varies with the part of the skin from which it is made. The skin from the upper

part of the body and along the back is closer fibered than that from the lower part, under the body; it becomes more open textured and consequently more porous as it passes from the backbone to the under side of the body. The skin over the posterior portion of the body is of closer texture than that over the forequarters; consequently the best leather is made from the hide in the region of the kidneys and hips, provided the skin is sound and not damaged in tanning. The leather from the "flanks" and "bellies" is more porous, lighter, and more flexible than that made from the "back," and in cutting the side of leather into soles the lighter and more flabby the lower portions the more of it is rejected. If, however, this lower portion has been stiffened and weighted with foreign material, no matter how useless it is nor how soon it may wash out, some shoe manufacturers will cut it into soles, thus obtaining more soles from a side. Because of these facts the shoe manufacturers calculate that weighted leather costs them less for each pair of soles than the unweighted leather.

Unloaded flabby leather makes poor shoe soles, and loading with materials readily soluble in water, as glucose and Epsom salts, increases the cost to the purchaser, and does not make soles more serviceable.

### WEIGHTING MATERIALS AND THEIR EFFECTS.

Loading or weighting materials are cheap. Those in most general use in this country are glucose, selling at 2 cents a pound; Epsom salts, or magnesium sulphate, selling at 1 cent a pound; and solutions of tanning or other organic materials, selling at 0.75 to 2 cents a pound. Barium sulphate and lead sulphate—generally formed by drumming the leather first in a solution of barium chlorid, costing 2 cents a pound, or of sugar of lead at 9 cents a pound, and then in sulphuric acid—and sodium sulphate, costing 1 cent a pound, are also employed to a small extent. Of these loading materials, glucose, soluble organic materials containing little or no tannin, magnesium sulphate, barium sulphate, lead sulphate, and sodium sulphate are much more objectionable than a small excess of actual tanning material.

Loading with glucose, Epsom salts, barium sulphate, lead sulphate, excessive quantities of tanning materials, or with water-soluble organic material is often detrimental to leather. It is made hard, brittle, more likely to crack, and after the loading washes out, as usually happens quite readily except in the case of barium and lead sulphates, it is more easily penetrated by water. Loaded leathers are more expensive, less durable, and a menace to health. A distinction should possibly be made between the effects of an excess of true tannin and of other uncombined or loading materials. The excess of true tannin may not itself be so objectionable and may even be of

temporary advantage, because the slowly soluble tannins make the leather more water resistant and impede the removal of combined tannin from the leather.

### QUANTITY OF ADDED WEIGHTING MATERIALS.

The amounts of materials found in the loaded leathers examined are summarized as follows: Ash, from 0.2 to 2.7 per cent; ether extract, from 0.4 to 5.6 per cent; Epsom salts, from 0.2 to 7.5 per cent; glucose, from 0.2 to 12.4 per cent; water-soluble materials, from 13.4 to 34.3 per cent; water-soluble tannin, from 6.1 to 17.8 per cent.

If it is feasible to secure the lower figures, as it appears to be in a number of tanneries, the higher figures must represent very excessive quantities. A comparison of these, together with those in the table on pages 16 to 20, with the figures given for normal leathers shows that the percentages of ash, Epsom salts, glucose, and water-soluble materials are, as a rule, above the permissible quantities, while the amounts of fats and oils and actual leather substance are lower than they should be. These figures show a serious moral, economic, and business condition. Approximately 63 per cent of the leathers examined are weighted with glucose, Epsom salts, or both. This loading varies from 1 to 7.5, with an average of 3, per cent of Epsom salts, and up to 10.4, with an average of 5.5, per cent of glucose, and amounts to a total maximum loading, when both are present, of 16 per cent and an average of 8 per cent.

### WASTE OF MATERIALS IN WEIGHTING SOLE LEATHER.

The tanners whose leathers have been examined produce a large percentage of the sole leather made in this country. It seems probable, therefore, that these samples are fairly representative of American sole leather, and if this be true fully 60 per cent of the sole leather is loaded with Epsom salts or glucose or both, and practically all of it contains more uncombined tanning materials than it should.

If 60 per cent of the sole leather contains an average of 8 per cent of Epsom salts and glucose, at least 150,000,000 pounds have been weighted annually with no improvement in its wearing value. The people have paid for not less than 12,000,000 pounds of Epsom salts and glucose, plus a profit to the tanner for working them into the leather, and have obtained nothing of value thereby. The average amount of water-soluble material in these sole leathers is 23 per cent. Subtracting from this the average percentage of glucose and Epsom salts found gives the percentage of what for brevity may be called "uncombined tanning" materials, meaning the materials derived from the tanning liquors in which the leather was tanned.

The almost universal practice of weighting or loading with excessive quantities of uncombined tanning materials is perhaps the most repre-

hensible form of weighting. It is needless and wastes valuable materials which can be employed in the production of more leather, and it often leads to bleaching or addition of glucose or Epsom salts to conceal the injury which frequently results from the presence of excessive quantities of uncombined tanning materials. The elimination of this waste would not only conserve our fast-diminishing native tanning materials, but reduce the quantity imported, and thus help maintain the balance of trade in favor of this country. It is an astonishing fact that practically all the leathers analyzed contain as much uncombined tannin as good quality oak or hemlock bark and many contain much more. Inspection of the tables shows that approximately one-third of the tannin in these leathers is uncombined, the quantity varying from 9 to 17 per cent. This is sufficient to tan one-third as much sole leather as is now made. Fully half of this wasted tannin can and should be saved. It is worth approximately $1,000,000 and would tan approximately 100,000,000 pounds of leather. This tanning material is now practically a total loss.

For the past 15 or 20 years energetic efforts have been made to prepare from the waste liquors produced by making paper from wood by the sulphite process products that will tan hides. The woods from which paper pulp is made, with but few exceptions, do not contain more than from 2 to 4 per cent of tannin. If this is all removed by the sulphite liquors which are subsequently concentrated to 50 per cent solids, the concentrated material offered for tanning purposes can contain at most but 4 or 5 per cent of tannin. Up to the present efforts to make leather with waste sulphite liquors have been crowned, at most, with but indifferent success, and in no case do the makers of these products from sulphite liquors advocate that they be used alone in tanning, but always in mixture with materials of known tanning value. These materials are now receiving careful attention from several sources for determining finally whether they have a proper place in the making of leather. Until such time as it shall have been shown that these products will make serviceable leather or that they contribute to the desirable qualities of leather they should not be used in commercial tanning.

### DETECTION OF WEIGHTING.

Although it is not practicable for the ordinary individual to determine whether the leather in shoes has been weighted or loaded, the shoe manufacturer can do so in a very simple way. Large quantities of Epsom salts give leather the characteristic bitter taste of the salts, while glucose in quantity gives the leather a very faint sweetish taste.

Whether or not leather has been loaded with soluble materials can be readily determined by anyone by the following simple procedure: Grind a sample of the leather (a pair of soles serves well) to a

coarse powder in any convenient way. The leather may be rasped, cut with a chisel or shears, ground in a mill, or sawed. Weigh 100 grams of the ground leather on a scale that will weigh accurately to 1 gram. Place it in a small, dry, close-textured cotton bag which has been washed to remove the starch and other dressing materials from the fabric and which has been given an identifying mark which will not wash out in hot water. Tie securely the mouth of the bag, weigh the bag and leather carefully, and record the weight. Place it in running water as hot as can be readily borne by the hand, and wash out the soluble materials by thorough kneading for 15 minutes. Squeeze out the water and dry over the radiator or in any convenient way until the leather is perfectly dry. Cool and weigh again. The loss in weight represents the amount of soluble matter which has been washed out. This loss in grams, as thus determined directly represents also the percentage loss, and if this exceeds 15 per cent the leather may safely be said to be weighted.

The following figures show some results actually obtained by this method and also the results obtained in careful analysis of the leather:

*Water-soluble material in leather.*

| Sample No. | Water-soluble material. | | |
|---|---|---|---|
| | Regular analysis. | Washed out in 10 minutes. | Washed out in 20 minutes. |
| | *Per cent.* | *Per cent.* | *Per cent.* |
| 2119 | 25 | 20 | 20 |
| 2127 | 28 | 24 | 24 |
| 2130 | 32 | 34 | 34 |
| 2134 | 25 | 24 | 24 |

For practical purposes the results obtained in this way are sufficiently accurate.

## BLEACHING OF SOLE LEATHER.

Leather which has been properly tanned with liquors made from chestnut or rock oak bark has been considered for generations to be the best for shoe soles. This leather has a bright light-oak color, the price which it brings depending very largely on this brightness and uniformity of color. As it comes from the tanning liquors leather is often quite irregular in coloring, and when made from nearly all other vegetable tanning materials it is darker in color than that tanned with oak bark. Irregularity of color is not necessarily a sign of inferiority, but, as a matter of fact, it generally indicates damage done in the preparation, tanning, or finishing of the leather, or stained or damaged places on the original hides. The shoe manufacturer knowing that uniform color is characteristic of hides prop-

erly prepared, tanned, and finished, and that oak bark makes a bright-colored leather, demands light, uniformly colored sole leather. The wearer of shoes also prefers leather with a good, clear, even color.

To secure the higher price which this much-desired uniformity, brightness of color, and the appearance of oak-tanned leather brings the leather is bleached. Solutions of soda and sulphuric acid applied successively, oxalic acid, or oxalic acid and tin chlorid are the chemicals with which this is usually done. The treatment removes some of the excess tanning material from the surface and gives the leather a much lighter color. Bleaching is especially detrimental, as the sulphuric acid is rarely completely neutralized and consequently greatly hastens the rotting of the leather. The cost of the leather is increased by this procedure; the serviceability of the leather is decreased; and the superior appearance secured in this way permits the fraudulent sale of the leather at a higher price. The bleaching of heavy leather is the most useless and harmful of all leather-making practices, and the most vigorous efforts should be made to eliminate it.

## MISBRANDING OF LEATHER.

Formerly all sole leather made in this country was tanned with oak or hemlock bark or a mixture of the two, and the leather so tanned was known as oak, hemlock, and union (oak and hemlock), respectively. More leather is tanned now with quebracho than with oak, and more with quebracho, mangrove, myrobalan, gambier, and chestnut, collectively, than with hemlock. Nearly half of the vegetable-tanned leather made in this country is tanned with materials other than oak and hemlock bark. Nevertheless, practically all vegetable-tanned leathers are still termed oak, hemlock, or union.

The figures in the table (pp. 16 to 20) show that many of the leathers are misbranded as to tannage. The tannin-free water extract from a leather tanned with chestnut oak is fluorescent when made faintly alkaline. It will be seen that the water solubles from some of the so-called oak leathers are not fluorescent; these leathers were not tanned with chestnut oak. The figures for water-soluble materials also show that many of these leathers were tanned with tanning materials other than oak or hemlock bark. Tanning liquors made from nearly all materials now used in this country, such as oak, hemlock, and mangrove barks, chestnut and gambier extracts, and myrobalan, contain approximately 2 parts of tannin to 1 part of nontannin, not including in the nontannin the sugars which the materials contain, which are fermented to acids and do not, therefore, add directly to the weight of the leather. Quebracho extract, on the other hand, contains approximately 7 parts of tannin to 1 part of nontannin.

In the last stages of tanning, the leather is in contact with practically fresh normal liquors in which the relations just stated hold. Therefore the tannins and nontannins of the water-soluble extracts from leather will tend to approximate the same ratio to each other as the liquors in which it was tanned. If the sum of glucose and magnesium sulphate is subtracted from the figures for the nontannins in any particular leather, the difference approximates the nontannin figures for the liquor in which the final tanning of the leather was conducted. A comparison of this figure with the figures for soluble tannin shows the ratio of tannin to nontannin in the liquor, and in many instances proves conclusively that tanning materials other than oak or hemlock bark were used. In fact, the ratio indicates that quebracho was used, but no intimation of the fact is given in the branding of the leather. The branding of all leathers—"oak," "hemlock," or "union"—is deceptive and the practice should be discontinued. No leather should be branded oak, hemlock, or union which is not tanned entirely with oak or hemlock or a mixture of the two.

The misbranding of leather is indicated by the recent census statistics. The percentage of oak leather reported in 1909 is 7 per cent greater than in 1904; the percentage of union leather is 32 per cent greater in 1909 than in 1904; while the quantity of hemlock and oak barks and extracts used in 1909 is materially less than in 1904.

## PREVENTION OF WEIGHTING AND BLEACHING.

It is improbable that the present practices of weighting and bleaching sole leather will be voluntarily discontinued by the tanner. Intelligent buying on the part of the public will do much to break up these practices. The individual purchaser of course can not know whether the leather in the shoes he buys is weighted or has been bleached, but if he will insist that they shall not be made of weighted or bleached leather and will not buy from those manufacturers who make such leather, the quantity of leather so treated will materially decrease, and it will be found that shoes are more durable and consequently less expensive.

The weighting and bleaching of leather may be easily and absolutely controlled by concerted action on the part of the shoe manufacturers. It is very simple for them to determine whether the sole leather delivered is weighted, and if they will refuse to buy such leather it will not be made. Shoe manufacturers will see to it that sole leather is not weighted if the public will take sufficient interest in the matter to demand unweighted leather.

## RESULTS OF ANALYSIS.

In the following list are given the names of the known tanners of the samples examined. These tanning firms are among the most representative producers of sole leather in this country. Probably a number of the leathers, the source of which is not known, were tanned by these known firms, but there is reason to think that many of them were produced by other tanners of sole leather.

MANUFACTURERS OF LEATHER.

Allen, N. R., & Sons, Kenosha, Wis.
American Oak Leather Co., Cincinnati, Ohio.
Cover & Co., Philadelphia, Pa.
Deford, The, Co., Baltimore, Md.
England-Walton Co., Philadelphia, Pa.
Harrington, Frederic, Dunnellon, N. Y.
Howes Bros., Boston, Mass.
Janney & Borrough, Philadelphia, Pa.
Kistler Lesh Co., Boston, Mass.
Leas & McVitty, Philadelphia, Pa.
McAdoo & Allen, Philadelphia, Pa.
Mooney, W. W., & Sons, Columbus, Ind.
Pfister & Vogel Leather Co., Milwaukee, Wis.
Rippman & Sons, Millerstown, Pa.
Smoot, C. C., & Sons, Alexandria, Va.
Toxaway Tanning Co., Rosman, N. C.
U. S. Leather Co., New York, N. Y.
Vaughan, Geo. C., Salem, Mass.
Vulcano Tanning Co., Boston, Mass.
Wilkinson, Rieger & Jones, Philadelphia, Pa.

The analytical results, so far as they are indicative of weighting or the presence of useless or harmful materials, are given in the following table:

*Analysis of leather.*

| Sample No. | Place sample was obtained. | Time sample was obtained. | Description of sample. | Tannage claimed. | Fluorescence. | Moisture. | Ash. | Petroleum ether extract. | Water-soluble material. | | | Epsom salts. | Glucose. | Combined tannins. | Hide substance. | Ratio of combined tannins to hide substance. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tannins. | Nontannins. | Total soluble. | | | | | |
| | | 1906. | | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | |
| 513 | Boston, Mass. | February | Sole, supposed to be weighted | Oak | + | 7.5 | 0.95 | 1.5 | 12.7 | 14.0 | 26.7 | ..... | 5.4 | 26.1 | 37.9 | 0.69 |
| | | 1907. | | | | | | | | | | | | | | |
| 1394 | do | February | No. 1, Texas oak sole | do | + | 6.9 | .8 | 4.9 | 17.0 | 6.8 | 23.8 | ..... | 1.5 | 24.7 | 39.4 | .63 |
| 1395 | do | do | No. 2, Texas oak sole | do | + | 6.5 | 2.1 | 1.7 | 10.2 | 18.9 | 29.1 | 3.9 | 5.7 | 30.9 | 31.5 | .98 |
| 1396 | do | do | No. 3, Hemlock sole | Hemlock | + | 7.3 | 1.9 | 2.2 | 14.8 | 11.9 | 26.7 | 1.5 | 7.2 | 25.8 | 37.7 | .68 |
| 1397 | do | do | No. 4, Oak sole | Oak | + | 6.9 | 1.2 | 4.0 | 15.1 | 6.4 | 21.5 | .5 | 2.6 | 29.2 | 38.1 | .77 |
| 1398 | do | do | No. 5, English pure bark | | + | 7.3 | 2.3 | 1.3 | 14.2 | 11.3 | 25.5 | .7 | .7 | 27.0 | 38.6 | .70 |
| 1399 | do | do | No. 6, Hemlock sole | Hemlock | + | 7.7 | 1.0 | 1.3 | 17.7 | 11.5 | 29.2 | 1.2 | 4.6 | 24.1 | 37.4 | .64 |
| 1400 | Baltimore, Md. | do | Oak sole | Oak | + | 6.8 | 2.6 | 1.0 | 14.9 | 18.4 | 33.3 | 4.7 | 12.0 | 21.4 | 37.2 | .58 |
| 1401 | do | do | Union sole | Union | + | 8.3 | 2.7 | 2.5 | 13.2 | 14.8 | 28.0 | 6.4 | 6.1 | 27.5 | 33.4 | .82 |
| 1402 | do | do | Texas oak sole | Oak | + | 8.3 | 1.7 | 1.5 | 13.7 | 13.1 | 26.8 | 4.0 | 5.3 | 28.5 | 34.6 | .82 |
| 1403 | do | do | Hemlock sole | Hemlock | + | 6.3 | 1.8 | .4 | 7.5 | 19.2 | 26.7 | 4.6 | 10.0 | 29.5 | 36.8 | .80 |
| 1404 | do | do | Texas scoured oak | Oak | + | 7.3 | .7 | 2.0 | 14.8 | 7.1 | 21.9 | .4 | 2.3 | 28.0 | 40.5 | .69 |
| 1405 | Boston, Mass. | do | Drum tanned | | − | 7.6 | .9 | .7 | 13.4 | 2.9 | 16.3 | 1.2 | .0 | 26.1 | 49.0 | .53 |
| 1406 | do | do | do | | − | 7.9 | .9 | 1.0 | 10.2 | 3.2 | 13.4 | .4 | .2 | 27.5 | 49.9 | .55 |
| 2077 | Unknown | June | No. 1 sole, No. 2 bend | Union | − | 8.8 | 1.9 | 3.2 | 14.4 | 16.1 | 30.5 | 4.4 | 9.2 | 23.8 | 33.4 | .71 |
| 2078 | Alexandria, Va. | do | Scoured oak sole, No. 1 bend | Oak | − | 4.4 | .3 | 4.7 | 15.6 | 4.6 | 20.2 | ..... | 1.2 | 33.0 | 37.4 | .88 |
| 2079 | do | do | do | do | + | 3.6 | .2 | 3.3 | 14.9 | 5.1 | 20.0 | ..... | 1.8 | 32.5 | 40.3 | .81 |
| 2080 | do | do | Scoured oak, extract tanned (in wheel after vat). | do | + | 3.8 | .3 | 3.5 | 14.2 | 5.0 | 19.2 | ..... | 1.5 | 33.3 | 39.9 | .83 |
| 2081 | do | do | Vat-tanned belting, No. 1 butt | | − | 4.9 | .2 | 5.3 | 11.5 | 5.5 | 17.0 | ..... | 1.3 | 34.5 | 38.0 | .91 |
| 2082 | do | do | No. 2 side | Hemlock | − | 5.8 | .9 | 3.3 | 14.8 | 12.1 | 26.9 | 1.4 | 6.2 | 28.0 | 35.7 | .78 |
| 2083 | do | do | Oak | Union | + | 5.9 | 1.2 | 4.5 | 14.2 | 9.7 | 23.9 | 2.4 | 2.7 | 30.8 | 34.6 | .89 |
| 2084 | Washington, D. C. | do | Scoured oak | Oak | + | 6.3 | 1.0 | 5.5 | 13.6 | 10.8 | 24.4 | 3.0 | 2.5 | 27.7 | 35.8 | .77 |
| 2085 | do | do | do | do | + | 7.0 | .6 | 3.7 | 13.2 | 6.8 | 20.0 | ..... | 1.5 | 32.4 | 36.6 | .89 |
| 2086 | do | do | do | do | + | 6.3 | .5 | 4.4 | 13.5 | 7.7 | 21.2 | ..... | 2.0 | 28.0 | 39.8 | .70 |
| 2087 | do | do | do | do | + | 5.5 | 1.0 | 1.9 | 12.6 | 17.9 | 30.5 | 2.1 | 7.2 | 26.8 | 35.0 | .77 |
| 2114 | do | do | Hard-rolled scoured oak | do | − | 8.0 | 1.9 | 2.9 | 15.4 | 15.0 | 30.4 | 6.1 | 5.5 | 25.9 | 32.5 | .80 |
| 2115 | do | do | do | do | − | 8.2 | 1.4 | 2.3 | 14.9 | 12.9 | 27.8 | 4.4 | 4.4 | 27.5 | 33.9 | .81 |
| 2116 | do | do | Scoured oak | do | + | 6.9 | 1.5 | 2.5 | 10.1 | 12.5 | 22.6 | 1.0 | 6.1 | 27.7 | 40.0 | .69 |
| 2117 | do | do | do | do | + | 7.7 | 1.5 | 3.1 | 9.3 | 10.7 | 20.0 | .5 | 5.1 | 26.4 | 42.5 | .62 |
| 2118 | do | do | do | do | + | 8.9 | 2.4 | 1.2 | 12.5 | 14.9 | 27.4 | 2.8 | 4.0 | 30.0 | 32.2 | .93 |
| 2119 | do | do | do | do | + | 8.2 | 1.4 | 1.5 | 13.4 | 11.6 | 25.0 | 4.1 | 2.4 | 29.5 | 35.5 | .83 |
| 2120 | do | do | Texas scoured oak | do | + | 8.0 | .5 | 4.1 | 15.3 | 6.5 | 21.8 | .6 | .6 | 25.1 | 40.7 | .62 |
| 2121 | do | do | do | do | − | 7.7 | .4 | 3.6 | 15.3 | 2.4 | 17.7 | .4 | .8 | 29.1 | 41.6 | .70 |
| 2122 | do | do | Scoured | do | − | 7.6 | 1.0 | 4.4 | 9.4 | 10.9 | 20.3 | 3.2 | 2.8 | 26.7 | 40.7 | .66 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2123 | do | do | do | do | − | 8.9 | .9 | 3.6 | 11.6 | 8.5 | 20.1 | 2.3 | 2.1 | 23.3 | 43.8 | .53 |
| 2124 | do | do | Scoured oak sole | do | − | 8.1 | .5 | 1.9 | 14.7 | 6.7 | 21.4 | 1.0 | .5 | 30.9 | 37.4 | .82 |
| 2125 | do | do | do | do | − | 7.7 | .4 | 1.5 | 10.9 | 7.6 | 18.5 | 1.2 | 1.2 | 31.1 | 40.9 | .76 |
| 2126 | Baltimore, Md | do | Scoured oak | do | + | 7.2 | 1.4 | 1.6 | 14.8 | 19.5 | 34.3 | 4.9 | 9.6 | 23.6 | 33.0 | .72 |
| 2127 | do | do | do | do | + | 7.4 | 1.0 | 4.1 | 13.1 | 14.8 | 27.9 | 2.1 | 6.0 | 25.3 | 35.0 | .72 |
| 2128 | do | do | Texas scoured oak | do | + | 8.2 | .6 | 3.4 | 11.9 | 7.5 | 19.4 | .3 | 1.6 | 32.3 | 36.4 | .88 |
| 2129 | do | do | do | do | + | 8.9 | .4 | 2.0 | 13.6 | 5.9 | 19.5 | ..... | 1.4 | 30.0 | 39.3 | .76 |
| 2130 | do | do | Scoured oak | do | + | 8.8 | 1.5 | 1.0 | 13.6 | 18.7 | 32.3 | 4.5 | 3.5 | 25.2 | 32.4 | .78 |
| 2131 | do | do | Hemlock sole | Hemlock | − | 8.3 | 2.5 | 1.3 | 9.3 | 22.1 | 31.4 | 5.7 | 12.4 | 25.7 | 33.0 | .78 |
| 2132 | do | do | do | do | − | 7.6 | 1.6 | 1.6 | 9.7 | 18.1 | 27.8 | 6.4 | 6.4 | 24.2 | 38.5 | .63 |
| 2133 | do | do | Union sole | Union | − | 8.7 | 1.5 | 2.5 | 14.6 | 13.4 | 28.0 | 4.1 | 5.5 | 27.4 | 33.1 | .83 |
| 2134 | do | do | do | do | − | 7.4 | 2.0 | 3.7 | 13.5 | 11.0 | 24.5 | 3.8 | 5.4 | 28.5 | 35.6 | .80 |
| 2135 | do | do | Hemlock sole | Hemlock | − | 8.4 | 1.2 | 1.2 | 12.0 | 17.5 | 29.5 | 2.8 | 10.5 | 28.9 | 31.7 | .91 |
| 2136 | do | do | do | do | − | 7.7 | .9 | 1.1 | 14.1 | 14.9 | 29.0 | 2.0 | 8.2 | 27.3 | 34.6 | .78 |
| 2137 | do | do | Scoured oak | Oak | + | 8.2 | .3 | 1.3 | 13.7 | 6.1 | 19.8 | ..... | 1.5 | 33.1 | 37.3 | .89 |
| 2138 | do | do | do | do | + | 8.2 | .4 | 1.1 | 14.0 | 5.9 | 19.9 | ..... | 1.2 | 31.3 | 39.2 | .80 |
| 2139 | do | do | do | do | + | 12.3 | .5 | .9 | 10.9 | 7.1 | 18.0 | ..... | 1.2 | 28.9 | 39.6 | .73 |
| 2140 | do | do | do | do | + | 7.9 | .5 | .7 | 10.5 | 7.3 | 17.8 | ..... | 1.5 | 32.4 | 40.9 | .79 |
| 2141 | do | do | do | do | + | 8.4 | 1.2 | 1.1 | 13.2 | 14.5 | 27.7 | 1.9 | 5.9 | 27.0 | 35.5 | .76 |
| 2142 | do | do | do | do | − | 8.6 | .9 | 2.3 | 12.0 | 12.6 | 24.6 | 2.5 | 5.6 | 27.0 | 37.2 | .73 |
| 2143 | do | do | Vat (no extract) scoured oak | do | − | 7.5 | .3 | 2.9 | 11.5 | 6.1 | 17.6 | ..... | 1.8 | 29.5 | 42.2 | .69 |
| 2143k | do | | do | do | − | 7.6 | .3 | 2.6 | 12.9 | 4.7 | 17.6 | ..... | .5 | 29.0 | 42.9 | .68 |
| 2295 | Alexandria, Va | July | Vat, chestnut oak extract, scoured oak | do | + | 7.9 | .3 | 1.9 | 12.6 | 4.6 | 17.2 | ..... | .4 | 34.2 | 38.5 | .89 |
| 2296 | do | do | Vat, chestnut oak extract, and quebracho. | do | + | 7.3 | .4 | 2.4 | 14.4 | 4.7 | 19.1 | .3 | .5 | 34.4 | 36.5 | .94 |
| 2296k | do | do | do | do | + | 7.9 | .4 | 3.7 | 12.4 | 5.5 | 17.9 | ..... | .4 | 33.3 | 36.9 | .90 |
| 2297 | do | do | do | do | + | 8.2 | .2 | 1.5 | 14.4 | 6.3 | 20.7 | ..... | .6 | 34.4 | 34.9 | .99 |
| 2298 | do | do | do | do | + | 8.4 | .2 | 1.8 | 13.8 | 5.8 | 19.6 | ..... | .5 | 34.8 | 35.1 | .99 |
| | | 1909. | | | | | | | | | | | | | | |
| 9695 | St. Louis, Mo | September | No. 1, Texas oak | do | + | 5.8 | .7 | 3.6 | 17.3 | 9.8 | 27.1 | ..... | 2.7 | 25.4 | 37.8 | .67 |
| 9696 | do | do | No. 2, union | Union | − | 5.1 | 2.4 | 5.6 | 14.7 | 18.9 | 33.6 | 7.5 | 6.5 | 25.1 | 30.3 | .83 |
| 9697 | do | do | No. 3, extract tanned, oak | Oak | + | 4.1 | 1.9 | 5.6 | 12.9 | 13.1 | 26.0 | 3.5 | ..... | 27.1 | 36.9 | .73 |
| 9698 | do | do | No. 4, oak | do | − | 4.1 | 1.3 | 4.1 | 14.5 | 12.7 | 27.2 | 3.1 | 3.6 | 26.8 | 37.5 | .71 |
| 9699 | do | do | No. 5, extract tanned, union | Union | − | 4.2 | 1.6 | 2.5 | 16.2 | 10.2 | 26.4 | 3.9 | 3.4 | 28.3 | 38.3 | .74 |
| 9700 | do | do | No. 6, extract tanned | do | + | 3.4 | 1.0 | 4.0 | 14.2 | 11.4 | 25.6 | 2.9 | 4.3 | 29.3 | 37.4 | .78 |
| 9701 | do | do | No. 7, weighted, hemlock | Hemlock | − | 3.6 | .9 | 1.8 | 11.7 | 12.9 | 24.6 | 2.1 | ..... | 27.1 | 42.6 | .64 |
| 9702 | do | do | No. 8, hemlock | do | − | 4.7 | 1.2 | 1.9 | 11.6 | 17.4 | 28.7 | 2.1 | 5.9 | 29.7 | 34.7 | .86 |
| 9703 | do | do | No. 9, extract, union | Union | − | 4.2 | 1.1 | 2.0 | 14.2 | 11.3 | 25.5 | 2.7 | 3.7 | 28.7 | 39.3 | .73 |
| 9704 | do | do | No. 10, adulterated, South American dry hide. | | − | 4.7 | 2.7 | 2.9 | 15.5 | 21.2 | 36.7 | 3.8 | 2.8 | 25.8 | 29.6 | .87 |
| 9705 | do | do | No. 11, belly, oak | Oak | + | 5.4 | .5 | 3.8 | 11.4 | 13.0 | 24.4 | ..... | 3.7 | 25.7 | 40.4 | .64 |
| 9706 | do | do | No. 12, extract, hemlock | Hemlock | − | 5.6 | .4 | 1.4 | 15.8 | 7.6 | 23.4 | ..... | ..... | 26.2 | 43.1 | .60 |
| 9707 | do | do | No. 13, so-called oak | Oak | + | 6.3 | 1.5 | 3.5 | 9.2 | 12.2 | 24.4 | 4.7 | 3.6 | 27.3 | 38.2 | .71 |
| 9708 | do | do | No. 14, oak | do | − | 4.3 | .7 | 3.4 | 6.1 | 10.6 | 16.7 | ..... | 5.2 | 29.1 | 46.2 | .63 |
| 9709 | do | do | No. 15, oak back | do | + | 4.8 | .8 | 4.3 | 13.7 | 10.3 | 24.0 | ..... | 5.6 | 26.7 | 39.9 | .67 |
| 9710 | do | do | No. 16, weighted, hemlock | Hemlock | − | 5.7 | 1.9 | 2.3 | 14.9 | 20.2 | 35.1 | 3.4 | 10.7 | 24.4 | 32.2 | .76 |
| 9711 | do | do | No. 17, hemlock | do | − | 4.9 | .9 | 2.2 | 14.3 | 8.6 | 22.9 | 1.3 | 3.1 | 27.6 | 42.1 | .66 |
| 9712 | do | do | No. 18, South American dry hide, weighted. | do | − | 4.3 | 1.0 | 2.9 | 13.7 | 17.3 | 31.0 | 4.3 | 5.6 | 30.0 | 31.5 | .95 |
| [1] 9713 | do | do | No. 19, best | Chrome | − | 4.0 | 6.7 | 32.1 | .2 | 2.5 | 2.7 | ..... | 1.4 | ..... | 47.0 | ..... |

[1] Sample No. 9713: 5.02 per cent chromium trioxid in original sample.

*Analysis of leather*—Continued.

| Sample No. | Place sample was obtained. | Time sample was obtained. | Description of sample. | Tannage claimed. | Fluorescence. | Moisture. | Ash. | Petroleum ether extract. | Water-soluble material. | | | Epsom salts. | Glucose. | Combined tannins. | Hide substance. | Ratio of combined tannins to hide substance. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tannins. | Nontannins. | Total soluble. | | | | | |
| | | | | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | |
| | | 1909. | | | | | | | | | | | | | | |
| [1] 9714 | St. Louis, Mo. | September | No. 20, best | Chrome | − | 2.9 | 6.0 | 34.6 | 0.2 | 2.9 | 3.1 | ..... | 1.4 | ..... | 54.9 | ..... |
| 10035 | Portsmouth, Ohio | October | No. 1 | Union | − | 5.9 | 1.5 | 3.1 | 13.4 | 14.5 | 27.9 | 4.9 | 5.5 | 26.4 | 36.4 | 0.73 |
| 10036 | do | do | No. 2, oak | Oak | + | 5.7 | .6 | 2.1 | 10.4 | 13.5 | 23.9 | ..... | 8.6 | 25.6 | 42.4 | .60 |
| 10037 | do | do | No. 3 | Union | − | 5.9 | .8 | 2.5 | 13.5 | 9.7 | 23.2 | 2.6 | 2.8 | 30.1 | 38.0 | .79 |
| 10038 | do | do | No. 4 | Oak | + | 5.2 | .3 | 3.5 | 11.7 | 7.8 | 19.5 | ..... | 1.2 | 30.7 | 40.8 | .75 |
| 10039 | do | do | No. 5 | do | + | 5.8 | .3 | 1.4 | 12.0 | 7.6 | 19.6 | ..... | 1.5 | 31.0 | 41.9 | .74 |
| 10040 | do | do | No. 6 | do | + | 5.6 | .4 | .9 | 8.9 | 19.6 | 28.5 | .2 | 8.0 | 24.6 | 40.1 | .60 |
| 10041 | do | do | No. 7 | do | + | 6.4 | .3 | 1.3 | 12.2 | 7.0 | 19.2 | ..... | .9 | 29.4 | 43.4 | .68 |
| 10042 | do | do | No. 8 | Union | − | 4.8 | .9 | 2.5 | 12.1 | 9.8 | 21.9 | .2 | 3.8 | 28.0 | 42.5 | .66 |
| 10195 | Unknown | November | Sole, lot No. 110, iron, not treated | do | − | 5.9 | .4 | 4.7 | 9.8 | 3.7 | 13.5 | ..... | 1.0 | 28.1 | 47.5 | .59 |
| 10196 | do | do | Sole, lot No. 210, iron, treated about 6 per cent. | do | + | 6.2 | 2.3 | 2.0 | 10.0 | 13.5 | 23.5 | .2 | 9.2 | 26.7 | 41.3 | .65 |
| 10361 | do | December | No. 12 | do | − | 5.6 | .8 | 1.2 | 12.0 | 12.1 | 24.6 | ..... | .8 | 27.3 | 41.0 | .67 |
| 10362 | do | do | Dark color | do | + | 5.3 | .2 | 4.3 | 12.2 | 5.8 | 18.0 | ..... | 1.4 | 36.4 | 35.7 | 1.01 |
| 10363 | do | do | do | do | + | 5.4 | .3 | 2.9 | 10.7 | 5.9 | 16.6 | ..... | 1.0 | 40.3 | 34.5 | 1.16 |
| 10364 | do | do | Green yellow cast | Oak | − | 4.9 | .3 | 2.5 | 14.1 | 4.3 | 18.4 | ..... | .8 | 31.2 | 42.7 | .73 |
| 10365 | do | do | Green yellow, redder than above | do | − | 5.6 | .3 | 1.4 | 14.5 | 4.4 | 18.9 | ..... | .9 | 31.8 | 42.0 | .75 |
| 10367 | do | do | Hemlock back | Hemlock | − | 5.6 | .8 | 3.2 | 14.4 | 13.9 | 28.3 | ..... | 9.7 | 32.4 | 30.2 | 1.07 |
| | | 1910. | | | | | | | | | | | | | | |
| 15058 | Washington, D. C. | January | Oak | do | .... | 9.3 | 1.2 | 1.1 | 17.8 | 7.7 | 25.5 | 1.2 | 2.5 | 29.3 | 34.5 | .85 |
| | | 1911. | | | | | | | | | | | | | | |
| 15543 | Alexandria, Va. | February | Scoured oak sole | Oak | + | 7.2 | .2 | 1.9 | 13.9 | 5.3 | 19.2 | ..... | .7 | 34.0 | 37.5 | .90 |
| 20635 | Washington, D. C. | October | Flexible oak bend | do | + | 8.2 | .4 | 3.9 | 11.7 | 18.5 | 30.2 | ..... | 10.2 | 23.5 | 33.9 | .69 |
| 20636 | do | do | Oak sole | do | .... | 8.9 | .2 | 4.0 | 12.9 | 5.3 | 18.2 | ..... | .7 | 26.9 | 41.8 | .64 |
| | | 1912. | | | | | | | | | | | | | | |
| 21764 | Portsmouth, Ohio | March | | Union | + | 6.3 | .7 | 2.6 | 13.0 | 8.5 | 21.5 | 1.9 | 2.3 | 27.7 | 41.6 | .66 |
| 21765 | do | do | | do | .... | 5.9 | 1.0 | 1.1 | 11.2 | 10.1 | 21.3 | 3.8 | 4.2 | 29.2 | 42.2 | .69 |
| 21766 | do | do | | do | .... | 6.8 | 1.5 | 2.9 | 12.5 | 11.8 | 24.3 | 4.6 | 4.6 | 27.8 | 37.9 | .73 |
| 21767 | do | do | | Hemlock | − | 5.6 | 1.9 | 1.6 | 13.0 | 14.4 | 27.4 | 2.5 | 6.9 | 28.4 | 36.7 | .77 |
| 21768 | do | do | | Oak | + | 5.9 | .7 | 2.5 | 14.8 | 7.7 | 22.5 | 1.5 | 1.7 | 28.7 | 40.1 | .71 |
| | Average | | | | .... | 6.6 | 1.1 | 3.4 | 12.8 | 10.5 | 23.3 | 2.7 | 3.8 | 28.5 | 38.2 | .75 |
| | Average in weighted samples | | | | .... | ..... | ..... | ..... | ..... | ..... | ..... | 3.0 | 5.5 | ..... | ..... | ..... |

[1] Sample No. 9714: 1.32 per cent chromium trioxid in original sample; 0.30 per cent chromium trioxid in water soluble.

The leathers here analyzed were secured from various sources; some were sent by tanners, some by shoemakers, some by sole cutters, and others were purchased from dealers. In some cases it was impossible to learn who tanned the leather; in the other cases the name of the tanner was given by the dealer, or his trade-mark or name appeared on the leather. Beyond this nothing is known as to the source of the leathers.

In the third column the approximate date of receipt of the leather is indicated. It will be observed that many of these samples are 5 or 6 years old. Comparison with samples taken more recently does not indicate material change in tannery practice with respect to loading.

Referring to the tables, the "Moisture" consists of the water which the leather exposed to the air naturally contains in addition to all the water of crystallization of any Glauber's salts, or sodium sulphate, and five-sevenths of the water of crystallization of any Epsom salts, or magnesium sulphate, which may be in the leather.

In the column headed "Ash" are given the residues from burning the leather. These residues include the ignited, dehydrated soluble salts which may have been in the leather, such as Epsom and Glauber's salts.

Parker [1] has shown in an extended investigation that the insoluble ash of sole and harness leathers, even though they be heavily weighted with soluble salts, averages less than 0.2 per cent, and very rarely exceeds 0.3 per cent. As none of these leathers was weighted with insoluble minerals, in those cases where the ash exceeds 0.3 per cent such excess is included as part of the total water-soluble material and so treated in calculating the combined tannin.

The column headed "Petroleum ether extract" shows the percentage of fats and greases which the various leathers contain.

The "Water soluble material" embraces soluble tannins and nontannins. The latter include glucose, Epsom salts (minus five-sevenths of its water of crystallization, which is included under moisture), and practically all but about 0.3 per cent of the ash. The sum of the moisture, insoluble ash (assumed here to be 0.3 per cent), total water soluble, and the hide substance (calculated from the determination of nitrogen) subtracted from 100 approximately equals the combined tannin, which is combined with hide to form leather.

The figures for Epsom salts show the amount of this salt ($MgSO_4 + 7H_2O$) present in the air-dried leathers. The column headed "Glucose" shows the amounts of water-free glucose and dextrin which the leathers contained, calculated as dextrose. In the last column is given the ratio of combined tannin to hide; that is, the number of parts of tannin combined with 1 part of hide to form leather substance.

[1] J. Soc. Chem. Ind., 1910, *29*: 315.

As will be seen, this quantity does not vary greatly from 0.7 part. In those cases where it is materially greater, it is probable that the leather contained many difficultly soluble reds, or uncombined tannins which were not completely extracted from the leather.

## SUMMARY.

A large majority of the samples examined contained an unnecessary quantity of uncombined tanning material. But little less than $1,000,000 worth of tannin is wasted annually in this way.

Sixty-three per cent of the leathers examined were weighted with glucose, with Epsom salts, or with both. The quantity of loading varied from 1 to 7.3 per cent of Epsom salts, with an average of 3 per cent. The maximum quantity of glucose in the loaded leathers was 10.4 per cent and the average 5.5 per cent. The maximum amount of these loading materials found in any leather was 16 per cent and the average where both were present was 8 per cent. The results obtained indicate that not less than 12,000,000 pounds of glucose and Epsom salts are sold annually in sole leather to the American people.

The materials add absolutely nothing to the wearing value of the leather and where present in large quantity may positively decrease its wear. Shoes made from these leathers are readily penetrated by water. Loading makes leather more costly, consequently an inferior leather costs more than a good leather.

Leather-making raw materials are wastefully consumed, the product may be inferior, the cost increased, and health is endangered by the prevalent practices of weighting and bleaching sole leather.

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